

The Invention Claimed Is:

1           1. An apparatus for determining a location of at least an image of a  
2 transmitter transmitting a signal, the apparatus comprising:

3                 a plurality of at least three antennas, separated by respective known  
4 distances, configured to receive the signal, each of the plurality of antennas receiving  
5 the signal at a respective time; and

6                 a processor coupled to the plurality of antennas, the processor  
7 configured to determine the location of at least the image of the transmitter responsive  
8 to at least the respective known distances and differences among the respective times.

1           2. The apparatus of claim 1, wherein the apparatus is a wireless  
2 communication device configured for use in a wireless communication network  
3 including a plurality of sub-networks and wherein the processor is further configured to  
4 manage hand-offs between the sub-networks responsive to the determined location of  
5 at least the image of the transmitter.

1           3. The apparatus of claim 1, further comprising:

2                 a display coupled to the processor for presenting the determined location  
3 of at least the image of the transmitter.

1           4. The apparatus of claim 1, wherein the signal is an Ultra Wideband  
2 (UWB) signal and wherein the plurality of antennas are configured to receive UWB  
3 signals and the processor is configured to process the UWB signals.

1           5. The apparatus of claim 1, wherein at least three of the plurality of  
2 antennas are in a substantially straight line.

1           6. The apparatus of claim 5, wherein at least one other antenna of  
2 the plurality of antennas is not in the substantially straight line.

1           7. The apparatus of claim 1, further comprising:

2                   a plurality of receivers, each receiver comprising at least one of the  
3       plurality of antennas, each receiver configured to receive GPS signals; and

4                   wherein the processor is further configured to determine the known  
5       distances responsive to the GPS signals.

1                   8.       The apparatus of claim 1, further comprising:

2                   a plurality of receivers, each receiver comprising at least one of the  
3       plurality of antennas, each receiver configured to receive GPS time signals to  
4       synchronize local time bases in each of the receivers; and

5                   wherein the processor is further configured to determine time differences  
6       responsive to the respective times referenced to the synchronized local time bases.

1                   9.       The apparatus of claim 1, wherein at least one of the plurality of  
2       at least three antennas is omni-directional.

1                   10.      An apparatus for determining a location of at least an image of a  
2       transmitter transmitting a signal, the apparatus comprising:

3                   a first antenna configured to receive the signal, the first antenna  
4       receiving the signal at a first time;

5                   a second antenna configured to receive the signal, the second antenna  
6       separated from the first antenna by a first known distance and receiving the signal at a  
7       second time;

8                   a third antenna configured to receive the signal, the third antenna  
9       separated from the first antenna by a second known distance and receiving the signal  
10      at a third time; and

11                  a processor coupled to the first, second, and third antennas, the  
12       processor configured to determine the location of at least the image of the transmitter  
13       responsive to at least the first and second known distances and differences between  
14       the first time and each of the second and third times.

1               11. The apparatus of claim 10, wherein the apparatus is a wireless  
2 communication device configured for use in a wireless communication network  
3 including a plurality of sub-networks and wherein the processor is further configured to  
4 manage hand-offs between the sub-networks responsive to the determined location of  
5 at least the image of the transmitter.

1               12. The apparatus of claim 10, further comprising:  
2                   a display coupled to the processor for presenting the determined location  
3 of at least the image of the transmitter.

1               13. The apparatus of claim 10, wherein the signal is an Ultra  
2 Wideband (UWB) signal and wherein the first, second, and third antennas are  
3 configured to receive UWB signals and the processor is configured to process the UWB  
4 signals.

5               14. The apparatus of claim 10, wherein the first, second, and third  
6 antennas are in a substantially straight line.

1               15. The apparatus of claim 14, further comprising:  
2                   a fourth antenna configured to receive the signal, the fourth antenna  
3 receiving the signal at a fourth time, not in the substantially straight line, and  
4 separated from one of the antennas by a third known distance;  
5                   wherein the processor is further coupled to the fourth antenna and  
6 configured to determine the location of at least the image of the transmitter responsive  
7 to the third known distance and differences between the fourth time and at least one of  
8 the first, second, and third times.

1               16. The apparatus of claim 10, further comprising:  
2                   a first receiver comprising the first antenna and the processor, the first  
3 receiver configured to receive GPS signals;  
4                   a second receiver comprising the second antenna, the second receiver  
5 configured to receive the GPS signals; and

6                   a third receiver comprising the third antenna, the third receiver  
7 configured to receive the GPS signals; and

8                   wherein the processor is further configured to determine the first and  
9 second known distances responsive to the GPS signals.

1                 17. The apparatus of claim 10, further comprising:

2                   a first receiver comprising the first antenna and the processor, the first  
3 receiver configured to receive a GPS time signal to synchronize a first local time base of  
4 the first receiver;

5                   a second receiver comprising the second antenna, the second receiver  
6 configured to receive the GPS time signal to synchronize a second local time base of  
7 the second receiver; and

8                   a third receiver comprising the third antenna, the third receiver  
9 configured to receive the GPS time signal to synchronize a third local time base of the  
10 third receiver; and

11                  wherein the processor is further configured to determine time differences  
12 responsive to the first, second, and third time signals referenced to the respective first,  
13 second, and third local time bases.

1                 18. The apparatus of claim 10, wherein at least one of the first,  
2 second, and third antennas is an omni-directional antenna.

1                 19. A method for determining a location of at least an image of a  
2 transmitter transmitting a signal with respect to a receiver having a plurality of at least  
3 three antennas separated by known distances for receiving the signal, the method  
4 comprising the steps of:

5                   determining differences in time between receipt of the signal at one of  
6 the plurality of antennas and at least two of the other antennas; and

7                   processing the known distances and the determined differences in time  
8 to determine the location of at least the image of the transmitter.

1               20. The method of claim 19, wherein the transmitter is part of a sub-  
2 network within a network including a plurality of sub-networks and wherein the method  
3 further comprises the step of:

4               managing hand-offs between the sub-network and another sub-network  
5 in the plurality of sub-networks responsive to the determined location of at least the  
6 image of the transmitter.

1               21. The method of claim 19, further comprising the step of:

2               presenting the determined location of at least the image of the  
3 transmitter.

1               22. The method of claim 19, wherein the signal is an Ultra Wideband  
2 (UWB) signal and wherein the determining step comprises the step of:

3               determining differences in time among receipt of the UWB signal at the  
4 plurality of antennas.

1               23. The method of claim 19, further comprising the steps of:

2               receiving a GPS time signal to synchronize a local time base in the  
3 receiver; and

4               wherein the processing step comprises the step of:

5               determining the differences in time referenced to the synchronized local  
6 time base.

1               24. A system for determining a location of at least an image of a  
2 transmitter transmitting a signal with respect to a receiver having a plurality of at least  
3 three antennas separated by known distances for receiving the signal, the system  
4 comprising:

5               means for determining differences in time between receipt of the signal  
6 at one of the plurality of antennas and at least two of the other antennas; and

7               means for processing the known distances and the determined  
8 differences in time to determine the location of at least the image of the transmitter.

1               25.     The system of claim 24, wherein the transmitter is part of a sub-  
2 network within a network including a plurality of sub-networks and wherein the system  
3 further comprises:

4               means for managing hand-offs between the sub-network and another  
5 sub-network in the plurality of sub-networks responsive to the determined location of  
6 at least the image of the transmitter.

1               26.     The system of claim 24, further comprising:

2               means for presenting the determined location of at least the image of the  
3 transmitter.

1               27.     The system of claim 24, wherein the signal is an Ultra Wideband  
2 (UWB) signal and wherein the determining means comprises:

3               means for determining differences in time among receipt of the UWB  
4 signal at the plurality of antennas.

1               28.     The system of claim 24, further comprising:

2               means for receiving a GPS time signal to synchronize a local time base in  
3 the receiver; and

4               wherein the processing means comprises:

5               means for determining the differences in time referenced to the  
6 synchronized local time base.

1               29.     A computer readable medium including software that is configured  
2 to control a general purpose computer to implement a method for determining a  
3 location of at least an image of a transmitter transmitting a signal with respect to a  
4 receiver having a plurality of at least three antennas separated by known distances for  
5 receiving the signal, the method including the steps of:

6                   determining differences in time between receipt of the signal at one of  
7   the plurality of antennas and at least two of the other antennas; and

8                   processing the known distances and the determined differences in time  
9   to determine the location of at least the image of the transmitter.

1                 30.   The computer implemented method of claim 29, wherein the  
2   transmitter is part of a sub-network within a network including a plurality of sub-  
3   networks and wherein the method for implementation by the general purpose computer  
4   further comprises the step of:

5                   managing hand-offs between the sub-network and another sub-network  
6   in the plurality of sub-networks responsive to the determined location of at least the  
7   image of the transmitter.

1                 31.   The computer implemented method of claim 29, wherein the  
2   signal is an Ultra Wideband (UWB) signal and wherein the determining step for  
3   implementation by the general purpose computer further comprises the step of:

4                   determining differences in time among receipt of the UWB signal at the  
5   plurality of antennas.

1                 32.   The computer implemented method of claim 29, wherein the  
2   method for implementation by the general purpose computer further comprises the  
3   steps of:

4                   receiving a GPS time signal to synchronize a local time base in the  
5   receiver; and

6   wherein the processing step for implementation by the general purpose computer  
7   further comprises the step of:

8                   determining the differences in time referenced to the synchronized local  
9   time base.